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Impacts on Project Timeline & Cost by the use of Cold Formed Steel

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Abstract

The cold formed steel (CFS) is considered as a most light weight construction material used in steel construction industry. The Indian market could be a significant potential towards use of steel in residential sector in future decades. In this research, factors affecting cold formed steel construction and challenges tackled from those are studied in detail. The factors affecting contributes towards reduction of time and cost and has a positive impact on residential sector of developed countries. This study aims towards spreading awareness about efficient steel technique that can be used for mid-rise building construction in tier 1 and tier 2 cities of India. The CFS materials are used mostly in low-rise affordable housing systems in various regions. To prove the need of CFS technique adoption in residential sector of India, this research through survey of construction industry personal has been conducted. The expectation of economical construction within less time of construction is fulfilled by using CFS technique. The result of this study shows positive impacts on future construction industry. The ultimate aim is to address the need of change in techniques of construction to achieve time and cost-efficient solutions in future decades.

Important parameters: Cold Formed Steel (CFS), residential sector, cost, time, efficient

Introduction

In India, most of the residential mid-rise buildings are present in tier 2 & tier 1 cities. These buildings are constructed with the use of RCC technology with the height of 15m to 36m i.e., 5 to 12 floors. The conventional technology of construction is turning out to be rigorous for contractor and builder for its unpredictable performance during weather changes. The time required for curing affects the completion of project in time. To overcome these effects on construction, Cold Formed Steel (CFS) can be used for construction of mid-rise building structures.These types of construction are used in many of developed countries such as China, USA, UK, Japan and Germany. India being a developing country is yet to pursue the construction of midrise buildings in mega projects. In some of the rural areas, government has initiated the affordable housings in low rise structure using cold formed steel sections or

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light gauge steel sections in Northern India. This research is to analyse the CFS construction in India defining the cost and time effectiveness for clients and contractors.

The CFS construction can provide high structural stability and durability of withstanding midrise building in India. Some of the advantages of use of cold formed steel structureare light weight super structure, durability and resistance towards corrosion, mould & vermin, cost-effective in shorter project cycles and accuracy in design solutions,sustainability in recycling of steel more than 70%., ease of installation onsite, non-combustibility.

Need for cold formed steel construction

The use of cold form steel construction forms is diversified according to its use in affordable or low-cost housings. In modern day technology with increasing population there has been a need for affordable housings throughout the world. The selection of materials with respect cost effectiveness and less time consumption is important. The system used for construction should be easy for transportation and handling which will help in less wastage of materials and reducing time of the activity. The erection of CFS structure requires skilled labour as well as handling of panels is done by them. Less number of labours will be used for factory made assemblies and equipment or machineries can be used onsite for placing the panels. The diversified low-cost housing techniques using light weight steel in India are discussed. The type of light weight sections used for sub structure and super structure is based on load carrying capacity of structure

The tips for selection of material and method of construction are choosing right material, safety criteria satisfied, rising speed of project to its maximum value and making construction sustainable and more profitable by maintaining the quality. For cutting the construction cost many of the contractors in Washington DC are opting for CFS constructions. According to their review, CFS construction saves the cost by maintain the construction as per construction schedule in commercial sector. On-site labour work is reduced due to panelised structure and light weight parameter of CFS. This implies the labour cost reduction in the project. Due to midrise buildings of CFS and modular frames, placing of scaffolding and daily rents are decreased. These all parameters refer to financial cost cutting of project as compared to RCC construction.

Feasibility of CFS

The parameters beneficial using CFS are light weight structure as compared to RCC, time reducing & cost effectiveness, fire acoustics and sustainability in structure. In some of constructions BIM (Building Information modelling) is also used to improve project life cycle quality and flow of construction. In 80% of projects, BIM is being used for its data splitting and effectiveness. This reduces cost of project with respect to labours, machineries, equipment, materials and manpower. As the CFS is non-combustible material, this reduces the fire catching risk as compared to wood and RCC.

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Identification of Factors & Comparative Study

The comparative study of cold form steel and RCC structure with respect to time and cost is specified. The parameters helping to cut the construction costs with maintaining quality of work by using cold form steel are stated. The onsite construction is rigorous compared to offsite panelised or modular construction due to weather effects. The accuracy of steel construction can also reduce the project cycles due to its durability and adaptable qualities. The cost is reduced in site safety compliance parameter, modular construction increases onsite safety. Using CFS structure, fire is also prevented from spreading to adjacent structure compared to use of RCC or wood structures. Low cost housings in Egypt is the priority need as per government perspectives. Use of cold form steel structures, government can overcome time as well as cost parameter with maintaining the quality of structure. The case study of building 200 residential units has been referred to observe the use of different techniques in lean construction scheduling. In these mega residential projects single batch construction can lead to overrun of cost and time criteria. The two techniques used are batch based repetitive scheduling and conventional repetitive scheduling. Therefore, steel panels are deployed in 10 different batches manages 20 residential units in single batch to increase cost and time efficiency. The number of crews used for construction with respect to progress per crews is stated. The construction using conventional method took 1156 days to complete the project whereas batch method took 941 days for completing project with less number of crews. This proves the CFS panel construction using batch based repetitive method takes approximately 20% less time than that of conventional method. This technique saves material wastage and over production of steel.

Sustainable development is achieved by reducing energy consumption using material with low embodied energy, recyclable materials and using low energy building technology. The major limitation of these type of structure is limited shapes used for construction and its expenses. The standard for construction is varying in construction codes throughout the world i.e., standards are not set. The people in tier 2 and three cities are not familiar to these techniques and advantages of construction building using CFS material. The sustainability of CFS materialis defined in various sections such as environmental efficient steel, strength & durability, design method adaptability according to conditions, quality of high-performance steel, fire acoustics and recyclable materials. The methods used for CFS construction are aesthetic built, panel construction and modular construction. The difference between onsite and off-site construction is connected to labour quality i.e., skilled or unskilled used in construction.

Research Methodology

Questionnaire Summary

The validation of use of cold formed steel in future sustainable India is carried out in this study by preparing a questionnaire. The current scenario of using CFS in the countries like Japan, North America and Europe has upgraded its residential sector by huge margin. This

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survey is step towards use of this method in India for upgrading the residential sector. The survey covers the following important parameters:

- Form filling by personal strictly related to construction industry
- Factors affecting cold formed steel construction
- Challenges faced by construction industry due to RCC construction
- Over coming of these challenges by use of cold formed steel construction

In this study, there is a convincing try to prove the need of CFS construction should vastly affect the project timeline and cost simultaneously. If the time of construction is reduced, the cost will also reduce in the same manner. The inputs of construction industry personal is jointly important to carryout this study to boost awareness about CFS structures.

The multi -linear regression analysis is to be performed on factors affecting CFS construction. The results of this analysis will prove the most 2-3 important factors from which CFS construction in India could be boosted in coming years. The responses are interpreted in this analysis and results are analysed in results and analysis section.

Descriptive Survey Sections

Demographic Details

This section describes the experience of survey respondents in construction industry. Since this technique is new in India, it is mostly used for affordable housings in northern parts of the country. The expectation of recording as many experienced candidates to get a knowledgeable response was the ultimate goal of this survey. The number of respondents for this survey were 82. The division of respondents according to experience in construction industry is stated in following pie chart:

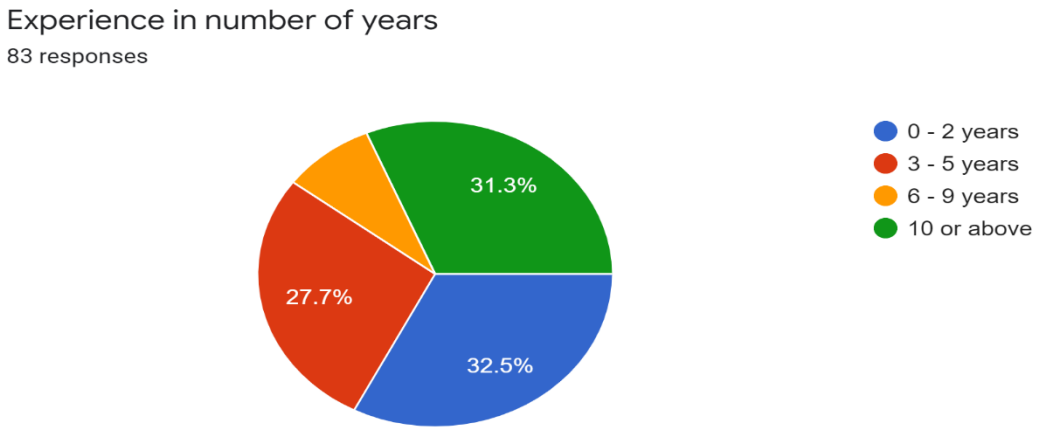

Figure 4:1: Demographic details of respondents

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This chart describes the category of experienced candidates filling the form is 77.5%. This survey was mainly designed for getting the responses from experience candidates who have immense knowledge about execution stage of construction life cycle using different types of methods. Overall, 33 respondents are of 6 or more years experience in this survey that means 39.7%. Factors affecting CFS

The following are important factors stated in survey:

Table 4-1: Factors affecting CFS

Code	Independent Factors	Dependent Factors
F1	Cost & time	Use of CFS can boost the construction speed
F2		CFS can produce light weight construction
F3		Reduction in cost by using composite structures i.e., Substructure+1 floor of RCC and super structure of CFS
F4		Space use can be flexible with respect to execution stage
F5		More photo voltaic Facade can be used for green constructions
F6		Material wastage can be conserved using this technology
F7		CFS Modular construction in the form of panelised systems can reduce the time of construction
F8		Sustainable and energy efficient with climate essential approach using CFS
F9		Recycling light weight steel can lead to cost reduction of project
F10		The innovation of CFS building in future can be done in low cost as compared to RCC

Challenges in Construction Industry

This section covers various challenges faced in construction life cycle particularly in India. The use of CFS structure reduces these challenges to a sustainable development status. The following are the challenges are specified in survey:

- Rising cost of materials
- Poor productivity
- Exceeding overall budget
- Skilled labour shortage
- Environmental damage

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These issues are addressed in next section with respondent's responses about the most affected in residential sector of country. Those results will show the issues to be tackled with the help of using CFS method.

ANALYSIS & RESULTS

In this section, the results of regression analysis done on factors affecting CFS structure are presented. The factors which the respondents proved has a most significant role in bringing CFS method into construction industry are stated through regression results. Due to these factors, the challenges overcome by CFS method are also stated in this analysis. The whole study of importance of methods and challenges tackled is the main motive of this research. Therefore, this section is divided into two following sections:

- Regression analysis of factors
- Challenges tackled by using CFS

Regression analysis

In this research, the factors are coded as F1 to F10 which affect the dependent variable i.e., cost and time. The terms in this analysis such as R square value, standard error, significance and p-value will indicate the fitness and reliability of model. The sample size of 82 respondents is evaluate for this analysis. The following is the result of analysis and importance explained:

Regression Statistics								
Multiple R	0.978642							
R Square	0.95774							
Adjusted R	0.951871							
Standard E	0.718094							
Observatio	83							
ANOVA								
	df	*SS*	*MS*	*F*	*ignificance F*			
Regressio	10	841.4268	84.14268	163.175	2.64E-45			
Residual	72	37.12746	0.515659					
Total	82	878.5542						
	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	0.339613	0.151188	2.2463	0.027753	0.038226	0.641	0.038226	0.641
F1	0.673788	0.251223	2.682038	0.009069	0.172985	1.174591	0.172985	1.174591
F2	-0.43683	0.262917	-1.66146	0.10097	-0.96094	0.08729	-0.96094	0.08729
F3	0.83052	0.280447	2.961411	0.004146	0.271458	1.389581	0.271458	1.389581
F4	-0.19124	0.268584	-0.71201	0.478758	-0.72665	0.344177	-0.72665	0.344177
F5	0.030522	0.245823	0.124162	0.901533	-0.45952	0.520562	-0.45952	0.520562
F6	0.034023	0.247222	0.13762	0.890925	-0.45881	0.52685	-0.45881	0.52685
F7	-0.31413	0.274249	-1.14541	0.255834	-0.86083	0.232579	-0.86083	0.232579
F8	1.02574	0.286524	3.579948	0.00062	0.454565	1.596914	0.454565	1.596914
F9	0.283538	0.288985	0.98115	0.329804	-0.29254	0.859619	-0.29254	0.859619
F10	0.404057	0.26109	1.547581	0.126108	-0.11642	0.92453	-0.11642	0.92453

Figure 5-1: Regression Analysis on Factors

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Goodness of fit

The term R Square indicates fitness of model and is considered as parameter of determination of sample. The r square value in this analysis is 95.77%. This means model is extremely fit for analysation of data performed. This means 95.775 of dependent variables i.e., (factors in Y axis F1 to F10) are explained by independent variables.The term Standard error indicates significance of regression analysis performed and is mutual to R-square value. The lower value will indicate certainty of regression equation interpreted. The value confirmed in this analysis is 0.718, which is another example of goodness if fit evaluation. This means the model is reliable for further equations. The significant F value is less than 0.05 means the model is reliable. The factors chosen are fit for further hypothesis and analysis.

Hypothesis Testing

The hypothesis is that factors influencing CFS method can be forecasted by ten factors presented in the survey i.e., F1 to F10 (refer table no.1). To test hypothesis, multiple regression analysis is done. The results of this analysis are stated in equation below:

Factors{F (10,82) = 163.175, p=<0.05}

Forecasted factors = 0.34 + 0673*F1 - 0.436*F2 + 0.83*F3 – 0.191*F4 + 0.03 * F5 + 0.03 *F6 – 0.314 *F7 + 1.025*F8 + 0.283 *F9 + 0.404 * F10

Table 5-1: Significant Factors

Codes	Significant Factors	P-value
F8	Sustainable and energy efficient with climate essential approach using CFS	0.0062
F3	Reduction in cost by using composite structures	0.00414
F1	Use of CFS can boost the construction speed	0.009

Forecasted factors = 0.34 + 1.025*F8 + 0.83*F3+ 0673*F1

Challenges Tackled

In this section, the respondents have specified their significant views on challenges which can be overcome by use of CFS method in current construction industry scenario especially in India. The following graph will indicate the weightage of challenges which can be tackled using this method:

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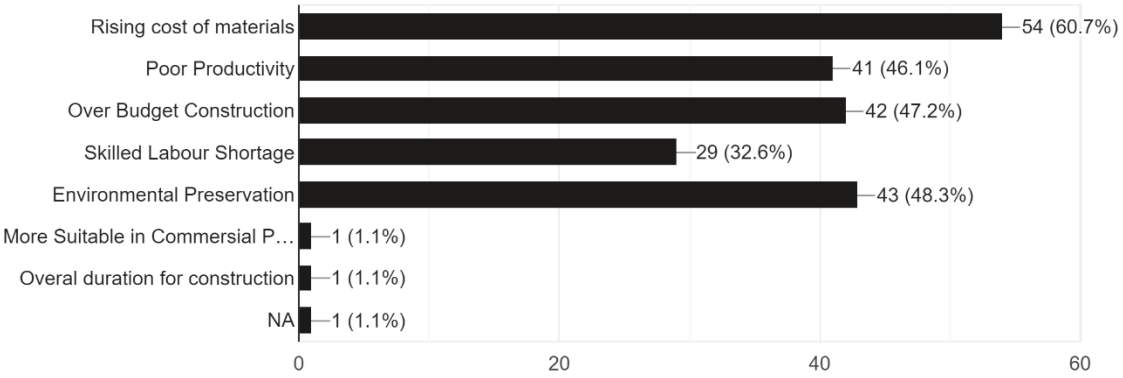

Figure 5-2: Challenges tackled by CFS

The serious issue to tackle is indicated by 60.7% of respondents in this survey. The second issue to tackle is stated as environmental preservation according to respondents rating as 48.3%.

Discussion

This research is divided into two parts i.e., first section consists of factors affecting CFS construction and second section is using those factors how the raised challenges are tackled. Three significant factors i.e., energy efficiency, composite structures use and rising speed of construction using CFS are directly proportional to efficiency in time and cost.

By the use of CFS method, the sustainable growth of residential sector of India and boost in steel production is expected in next 10-20 years. During execution stage of mid-rise building, speed of construction is drastically increased due to use of CFS panels and modules prefabrications. In residential as well as commercial buildings, the construction time of 6-7 months can be saved from per year ratio using CFS materials. (Build Steel, 2022)The accuracy of design and execution process is greater and speeds up construction process, reduces liabilities on site and decreased construction time cuts the over financing risks. Use of CFS can increase energy efficient solutions like solar facades used for controlling electricity of building, green roof solutions for low-rise structure, offers residents high end indoor air quality, recycling of steel will reduce use of fuel & energy and helps getting building LEED points. Especially construction in regional or tier 2 side of this country, people are not familiar with CFS material used for residentials, composite structure exposure will build a trust in material used in these areas. Durability of composite structures i.e., mixture of concrete cores and steel modules in earthquake prone and high wind regions is significantly high with respect to other structures. The logistical issues at site such as material management, truck loads scheduling, debris management is almost reduced due to prefabricated modules.These logistical methods will reduce wastage on site and cut the cost of materials and reduction in time due to scheduled delivery of materials immediately used for existing stage of construction. The most significant problems faced in nowadays construction of RCC are rising cost of materials due to delay and environmental preservation

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are conveniently tackled by all three factors influencing stated in survey results of cold formed steel structure use. With respect to cutting down the cost of construction, insurance risk is also reduced by use of durable cold formed steel channels.

Considering the whole survey, the last part was on the opinion of construction related personal of increasing cold formed steel construction in India. This opinion matters because there are only few CFS construction in present scenario in this country. The use of CFS in low rise structure in northern areas during “PradhaMnatriAwasYojna” was the first initiated construction in India. The importance of using this technique for sustainable future was to be surveyed in last part of this research. The following pie chart will prove a need of CFS materials in future constructions:

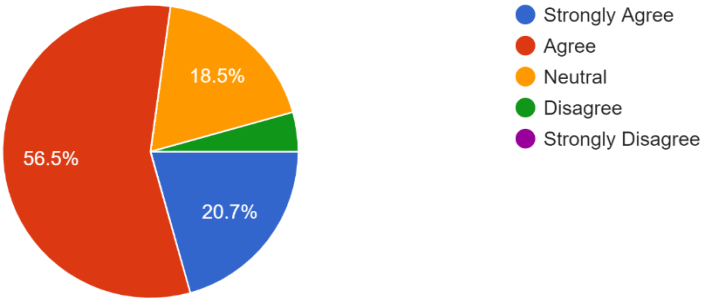

Figure 6-1: Interest in CFS construction

The above pie chart shows that about 77.2% of respondents are in the favour of boosting cold formed steel construction in India for sustainable growth of residential sector. The youth and experienced candidates in construction sector are eager to create more innovative solutions for fast and durable modules.

Conclusion

The initiative of this study is to create awareness about using cold formed steel material in construction of residentials in tier1 and tier cities of India. In the perspective of advantages CFS structure has more positive points to be considered in future use. The production of light weight steel in India is at highest peak in this decade and production will increase if construction materials can be replaced by durable CFS channels.There are certain limitations to this method i.e., it is more preferred as use in a low-rise commercial sector construction. To tackle this issue composite structures can be used at start of initiation turning from complex onsite construction to prefabricated techniques. The trend of mid-rise to high rise should be considered as an opportunity to boost steel innovative construction technologies which will benefit the industry with environmental preservation, energy efficient solutions, project cost reduction and significant speed of construction. The purpose of this survey to take reviews of construction industry personals helped to get insights about initiation in use of CFS in India.

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